Universal Interconnection Technology
Technology Roadmap Workshop

Associated Barriers to Distributed Generation

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1 Introduction

There are many issues that affect the successful implementation of Distributed Generation from both the customer and local utility perspective. The issues can be separated into four major categories.

- System Coordination Issues
- Present Day Universal Interconnection Technology (UIT) Systems
- Power Quality Concerns
- Utility/Regulating Body Paradigm Shift

2 System Coordination Issues

Many customers do not understand the importance of addressing system coordination issues before installing Distributed Generation (DG) systems. If a system is not properly coordinated it could result in equipment damage due to a severe fault current condition or unplanned outages due to improper system coordination.

2.1 Fault Current Considerations

Currently each site must be analyzed by a qualified engineer to determine the magnitude of the worst-case fault current condition. The engineer must develop a one line diagram and write a sequence of operations on how the sites DG will function. The consultant must contact the local utility and request the available fault current contribution for the site in question. Finally, the engineer must use the fault current contributions from the utility and DG, one line diagram, and sequence of events to determine the interruption rating of the UIT equipment. Another consideration is when the DG is operated in parallel with the utility; this will increase the required interruption rating of UIT equipment. The magnitude of the effect will depend on the type of DG used.

Most consultants use the conservative approach and assume infinite bus conditions in conjunction with the impedance of the utility transformer to determine the maximum fault current available to the site from the utility source. This is a nice general approach; however, the equipment may be oversized and more expensive than what was really required.

This is time consuming and adds cost to the implementation of DG. A possible alternative would be to conduct a comprehensive study of the US electric power system to determine what the worst-case available currents are throughout the US. Then, analyze the data to determine if the data follows some type of probability distribution. The study may reveal that at 70% of the sites the equipment can be rated 65kA. If the desire is to cover 90% of the sites then the equipment may need to be rated 100kA and if a really conservative approach is used of 100%, then the equipment may need to be rated 200kA. If this occurs, then analyze the data to see if there are any common parameters such as site voltage level, primary transformer size, primary transformer impedance, primary transformer voltage level, feeder size or other. The study would need to be published and endorsed by all utilities, so that all DG users throughout the USA can apply it.

2.2 Proper Coordination

In addition to determining the interruption rating of the UIT equipment, the consulting engineer must determine all of the protective settings. This can be done by hand or by using available software packages. The engineer must determine the breaker trip unit settings, which include long, short, instantaneous and ground fault settings. In addition, the protective relay trip settings must be determined for both the utility and the DG sources. The alarm settings must be determined so that the maintenance personnel have enough time to react to system disturbances before they become a trip condition. At this time, there is no means of short cutting this work.

3 Present Day UIT System Issues

There are many advantages to the new Universal Interconnection systems currently in the market. Over the past few years new embedded controllers have entered the market. These new controllers consolidated many functions, which required separate black boxes to perform discrete operations. Also, these separate boxes required many redundant point-to-point wiring terminations. Today many of these connections have been replaced by integral logic in one controller. All external inputs are wired to the embedded controller with the rest of the “connections” for different functions performed in the software. This has increased the functionality of the new systems and reduced the chance for wiring errors, decreased testing and commissioning times, and reduced overall system costs. This has lead to lower installed costs, which in turn have lowered the breakeven point for implementation of DG at many more sites.

There are a few disadvantages to these new systems. They are more complex and require a higher caliber startup engineer than the market place is accustomed to providing. Another issue is the varying degree of computer skills of the customer's maintenance personnel. The smallest issue could result in a significant amount of time troubleshooting a trivial issue.

While most customers have a desire to save money and/or explore the possibility of developing a second source of revenue, many do not understand DG. They are not knowledgeable about the different forms of DG, associated cost with each, system design requirements, or who at the local utility should be contacted to determine all requirements and available programs.

Solutions to these issues would be to increase plug and play capabilities. This would include developing menu driven software for UIT systems that work with prime movers to allow quick selection of Governors, voltage regulators, and prime movers. There should be defaults for all settable parameters that get the commissioning engineer close to stable system operation. Another alternative may be to add the governor and voltage regulator functions to the UIT embedded controller.

There needs to be a user friendly on-board software assistant that can review parameters and suggest appropriate changes for the commissioning engineer. In addition, the software must provide assistance to the site maintenance staff so that troubleshooting time can be minimized.

Educational material needs to be created that informs customers about DG with both positive and negative examples. The material needs to discuss what programs are available, different forms of peak shaving, associated pay back analysis, questions to ask the local utility provider and a review of the applications of various types of DG. After this information has been developed a vehicle is required to disseminate the information to interested parties. It could be as simple as putting the information on every state web site in multiple places or links to get interested customers to the right place.

4 Power Quality Concerns

There are two main issues of concern that affect electrical system power quality. They are Harmonics and Ferroresonance. Harmonics are becoming a more frequent issue with the increased use of inverter technology. Many harmonic issues are caused by the type of loads being served. One type of load that generates harmonics is variable speed drives. They can be purchased with different quality inverters (i.e. 6, 12 or 18 pulse inverters) that produce different levels of harmonics.

4.1 Harmonics

An issue that is often overlooked by customers purchasing a variable speed drive is what the harmonics content is when connected to the utility, DG or both (parallel operation). The higher the impedance of the source, the worse the affect of harmonics on the system.

For example, consider a customer site that contains a synchronous generator (15% impedance) as its DG source and a utility source (5% transformer). The site contains variable speed drives to operate pumps. The site can be operated on utility only, Generator only, or both in parallel. On utility only the total Harmonic Distortion (THD) is 2.3%. When on generator only the THD is 5.7%, but with both in parallel, the source impedance is reduced to 3.75% and the THD is reduced to 1.75%

The issue is that THD can cause the UIT system to misoperate if the levels are too severe, but implementation of DG is still positive from the utility perspective. If harmonics levels cause too much disturbance they could lead to flicker problems at other customer sites. Many times flicker problems are related to large electrical loads being switched off and on quickly like electric arc furnaces.

Some possible solutions would be to develop customer incentive programs. These programs should encourage customers to use equipment that produces low harmonics. Again, educational literature is needed that explains the issues associated with harmonics and how source impedance affects THD levels.

4.2 Ferroresonance

There are two types of ferroresonance, both produce sustained over voltages and core saturation. Saturation causes stray flux to be carried in the tank steel, which is a high-resistance short circuit by design. The losses from this condition could cause enough heat to raise the transformer oil to damaging levels. Ferronesonance can occur when a circuit with sufficient shunt capacitance energizes a lightly loaded transformer. Transformers at 14.4kV and above have enough internal shunt capacitance to produce ferroresonance on their own. This issue will need to be examined if DG is to be used to serve peak power requirements and/or create intentional islands.

5 Utility/Regulating Body Paradigm Shift

Currently, there is no incentive for utilities to use DG to offset Transmission and Distribution costs. Since utilities have separated into Distribution, Transmission, and Generation entities, their portfolios of operation are limited. For example, a distribution only utility is not permitted to own or dispatch generation assets; however, they are obligated to serve their customers. So, the utility will build transmission and distribution assets based on old paradigms and not consider using DG.

Possible Solutions to these issues would be to determine who should be given incentives to use DG. Maybe distribution type utilities should be allowed to negotiate contracts with DG customers and dispatch their generation resources in order to defer construction of new transmission lines and minimize distribution cost. Maybe the value from this type of approach should be split between the utility and their customers. Regulations should be changed to allow the utilities to have higher returns if they actively use DG to control system costs.

5.1 Distribution Utility Issues

The present distribution system in the United States was not designed for bi-directional power flow. Thus all of the stability and power flow models are based on having unidirectional power flow. The operating procedures for utilities requires them to supply 100% of their load requirements with enough safety margin equal to the largest generating resource, otherwise known as spinning reserve.

Possible solutions would be to develop bi-directional distribution systems to allow power flow from DG customer sites. This could include installing additional synchronism check relays throughout the distribution system. New stability and power models are required that would utilize DG. The new distribution system may be more costly, but transmission line costs should decrease. Also, central plant cost should decrease along with overall energy cost. Finally, new tariff structures are needed to support DG versus building traditional transmission and distribution systems.

Another issue that will need addressed is the subject of spinning reserve. Most DG units take at least a few seconds to produce rated voltage and assume load. The user systems may need to incorporate a new technology, such as online energy storage devices to ride through the periods were the DG is not producing power. Currently, there are systems available in the market place that could fill this need.